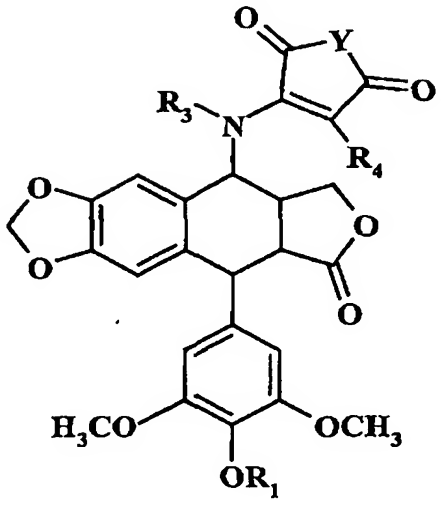
CLAIMS

1. Compounds of the formula (I):



(I)

wherein:

R_1 represents a group chosen among hydrogen, straight or branched (C_1-C_6) alkyl, aryl, straight or branched (C_1-C_6) arylalkyl, heteroaryl, straight or branched (C_1-C_6) heteroarylalkyl, straight or branched (C_1-C_6) alkylcarbonyl, arylcarbonyl, straight or branched (C_1-C_6) arylalkylcarbonyl, straight or branched (C_1-C_6) alkoxycarbonyl, aryloxycarbonyl, straight or branched (C_1-C_6) arylalkoxycarbonyl, heterocycloalkoxycarbonyl, straight or branched (C_1-C_6) alkylsulfonyl, arylsulfonyl, straight or branched (C_1-C_6) arylalkylsulfonyl, phosphonic, or $Si(R_a)_2R_b$ wherein R_a and R_b, identical or different, each represent a group chosen among straight or branched (C_1-C_6) alkyl, or aryl,

Y represents a group chosen among HN-NH or N-R_2 wherein:

R_2 represents a group chosen among hydrogen, straight or branched (C_1-C_6) alkyl, aryl, heteroaryl, cycloalkyl, heterocycloalkyl, straight or branched (C_2-C_6) alkenyl, straight or branched (C_2-C_6) alkynyl, or a group of the formula -T_1-R_5 wherein:

T_1 represents a group chosen among a straight or branched (C_1-C_6) alkylene chain, optionally substituted by one or more

groups chosen among hydroxy or straight or branched (C_1-C_6) alkoxy, a straight or branched (C_2-C_6) alkenylene chain, or a straight or branched (C_2-C_6) alkynylene chain,

R_5 represents a group chosen among hydroxy, straight or branched (C_1-C_6) alkoxy, straight or branched (C_1-C_6) alkylcarbonyl, straight or branched (C_1-C_6) alkylcarbonyloxy, straight or branched (C_1-C_6) alkoxycarbonyl, carboxy, halogen, trihalogenomethyl, aryl, heteroaryl, cycloalkyl, heterocycloalkyl, NR_cR_d wherein R_c and R_d, identical or different, each represent a group chosen among hydrogen, straight or branched (C_1-C_6) alkyl, straight or branched (C_1-C_6) aminoalkyl, wherein the amino part is optionally substituted by one or two identical or different groups, straight or branched (C_1-C_6) alkyl, straight or branched (C_1-C_6) hydroxyalkyl, straight or branched (C_1-C_6) alkoxy (C_1-C_6) alkyl,

or $C(O)NR'_cR'_d$ wherein R'_c and R'_d, identical or different, each represent a group chosen among hydrogen, straight or branched (C_1-C_6) alkyl, straight or branched (C_1-C_6) aminoalkyl, wherein the amino part is optionally substituted by one or two identical or different groups, straight or branched (C_1-C_6) alkyl, straight or branched (C_1-C_6) hydroxyalkyl, straight or branched (C_1-C_6) alkoxy (C_1-C_6) alkyl, or R'_c and R'_d together form a heterocycloalkyl with the nitrogen atom which carry them,

R_3 represents a group chosen among hydrogen, straight or branched (C_1-C_6) alkyl, cycloalkyl, straight or branched (C_1-C_6) cycloalkylalkyl, aryl, or straight or branched (C_1-C_6) arylalkyl,

R_4 represents a group chosen among hydrogen, straight or branched (C_1-C_6) alkyl,

the enantiomers, diastereoisomers, and addition salts thereof to a pharmaceutically acceptable acid or base,

it being understood that:

* by aryl is meant a group chosen among phenyl, biphenyl, naphthyl, dihydronaphthyl, tetrahydronaphthyl, indenyl, indanyl, and benzocyclobutyl, each of these groups optionally

containing one or more substitutions, identical or different, chosen among halogen, hydroxy, straight or branched (C_1-C_6) alkyl, straight or branched (C_1-C_6) alkoxy, cyano, nitro, amino, straight or branched (C_1-C_6) alkylamino, straight or branched (C_1-C_6) dialkylamino, carboxy, straight or branched (C_1-C_6) alkoxycarbonyl, straight or branched (C_1-C_6) trihalogenoalkyl, straight or branched (C_1-C_6) alkylcarbonyloxy, straight or branched (C_1-C_6) alkylcarbonyl, and aminocarbonyl wherein the amino part is optionally substituted by one or two groups, identical or different, straight or branched (C_1-C_6) alkyl,

* by heteroaryl is meant a monocyclic or bicyclic aromatic group or a bicyclic group of which one of the rings is aromatic and the other ring is partially hydrogenated, from 5 to 12 links, containing within the cyclic system from one to three heteroatoms, identical or different, selected among oxygen, nitrogen and sulfur, the aforementioned heteroaryl group optionally being substituted by one or more identical or different groups, selected among the substituents defined previously in the case of the aryl group; among the heteroaryl groups, pyridyl, pyrrolyl, thienyl, furyl, pyrazinyl, isothiazolyl, thiazolyl, oxazolyl, isoxazolyl, pyrimidinyl, indolyl, benzofuranyl, benzothienyl, quinolyl, isoquinolyl, benzo[1,4]dioxynyl and 2,3-dihydrobenzo[1,4]dioxynyl can be cited on a purely nonrestrictive basis,

* by cycloalkyl is meant a monocyclic or bicyclic group, saturated or unsaturated but without an aromatic character, containing from 3 to 12 carbon atoms, being optionally substituted by one or more groups, identical or different, selected among halogen, straight or branched (C_1-C_6) alkyl, straight or branched (C_1-C_6) trihalogenoalkyl, hydroxy, amino, straight or branched (C_1-C_6) alkylamino, and straight or branched (C_1-C_6) dialkylamino; among the cycloalkyl groups, cyclopropyl, cyclobutyl, cyclopentyl, and cyclohexyl can be cited on a purely nonrestrictive basis,

* by heterocycloalkyl is meant a cycloalkyl such as defined previously, containing within the cyclic system, from

one to two heteroatoms, identical or different, selected among oxygen and nitrogen, the aforementioned heterocycloalkyl being optionally substituted by one or more identical or different groups defined previously in the case of the cycloalkyl group; among the heterocycloalkyl groups, piperidyl, piperazinyl, morpholyl can be cited on a purely nonrestrictive basis.

2. Compounds of the formula (I) according to the claim 1 wherein R_1 represents a hydrogen atom, the enantiomers, diastereoisomers and addition salts thereof to a pharmaceutically acceptable acid or base.

3. Compounds of the formula (I) according to any of the claims 1 to 2 wherein R_3 represents a hydrogen atom, the enantiomers, diastereoisomers and addition salts thereof to a pharmaceutically acceptable acid or base.

4. Compounds of the formula (I) according to any of the claims 1 to 3 wherein R_4 represents a hydrogen atom or a methyl group, the enantiomers, diastereoisomers and addition salts thereof to a pharmaceutically acceptable acid or base.

5. Compounds of the formula (I) according to any of the claims 1 to 4 wherein Y represents a HN-NH or $N-R_2$ group wherein R_2 represents a straight or branched (C_1-C_6) alkyl group, straight or branched (C_2-C_6) alkenyl group, or a group of the formula $-T_1-R_5$ wherein T_1 and R_5 are such as defined in the formula (I), the enantiomers, diastereoisomers and addition salts thereof to a pharmaceutically acceptable acid or base.

6. Compounds of the formula (I) according to any of the claims 1 to 5 wherein Y represents a group of the formula NR_2 wherein R_2 represents a methyl group, the enantiomers, diastereoisomers and addition salts thereof to a pharmaceutically acceptable acid or base.

7. Compounds of the formula (I) according to any of the claims 1 to 6 wherein Y represents a group of the formula NR_2 wherein R_2 represents a $-T_1-R_5$ group wherein T_1 represents a straight or branched (C_1-C_6) alkylene chain, and R_5 represents a group chosen among aryl, carboxy and straight or branched (C_1-C_6) alkylcarbonyloxy, the enantiomers, diastereoisomers and addition salts thereof to a pharmaceutically acceptable acid or base.

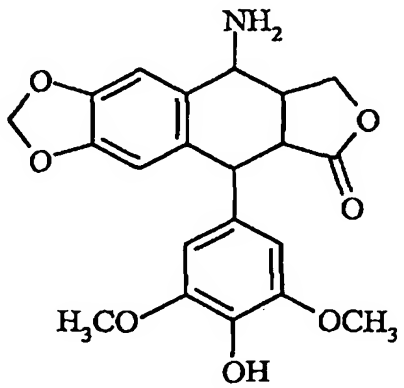
8. Compounds of the formula (I) according to any of the claims 1 to 7 wherein Y represents a group of the formula NR_2 wherein R_2 represents a $-T_1-R_5$ group wherein T_1 represents a methylene $-CH_2-$ group and R_5 represents an aryl group, the enantiomers, diastereoisomers and addition salts thereof to a pharmaceutically acceptable acid or base.

9. Compounds of the formula (I) according to the claim 1 which are:

- 3-{[(5*S*,5a*S*,8a*R*,9*R*)-9-(4-hydroxy-3,5-dimethoxyphenyl)-8-oxo-5,5a,6,8,8a,9-hexahydrofuro[3',4':6,7]naphtho[2,3-*d*][1,3]dioxol-5-yl]amino}-1-methyl-1*H*-pyrrole-2,5-dione;
- 3-{[(5*S*,5a*S*,8a*R*,9*R*)-9-(4-hydroxy-3,5-dimethoxyphenyl)-8-oxo-5,5a,6,8,8a,9-hexahydrofuro[3',4':6,7]naphtho[2,3-*d*][1,3]dioxol-5-yl]amino}-1-benzyl-1*H*-pyrrole-2,5-dione;
- 3-{[(5*S*,5a*S*,8a*R*,9*R*)-9-(4-hydroxy-3,5-dimethoxyphenyl)-8-oxo-5,5a,6,8,8a,9-hexahydrofuro[3',4':6,7]naphtho[2,3-*d*][1,3]dioxol-5-yl]amino}-1-(4-(fluorobenzyl)-1*H*-pyrrole-2,5-dione;
- 3-{[(5*S*,5a*S*,8a*R*,9*R*)-9-(4-hydroxy-3,5-dimethoxyphenyl)-8-oxo-5,5a,6,8,8a,9-hexahydrofuro[3',4':6,7]naphtho[2,3-*d*][1,3]dioxol-5-yl]amino}-1-[4-(trifluoromethyl)benzyl]-1*H*-pyrrole-2,5-dione;
- *N*-{4-[(3-{[(5*S*,5a*S*,8a*R*,9*R*)-9-(4-hydroxy-3,5-dimethoxyphenyl)-8-oxo-5,5a,6,8,8a,9-hexahydrofuro[3',4':6,7]naphtho[2,3-*d*][1,3]dioxol-5-yl]amino}-2,5-dioxo-2,5-dihydro-1*H*-pyrrol-1-yl)methyl]phenyl}acetamide;

- 6-(3-{[(5*S*,5a*S*,8a*R*,9*R*)-9-(4-hydroxy-3,5-dimethoxyphenyl)-8-oxo-5,5a,6,8,8a,9-hexahydrofuro[3',4':6,7]naphtho[2,3-*d*][1,3]dioxol-5-yl]amino}-2,5-dioxo-2,5-dihydro-1*H*-pyrrol-1-yl) hexanoic acid;
- 3-{[(5*S*,5a*S*,8a*R*,9*R*)-9-(4-hydroxy-3,5-dimethoxyphenyl)-8-oxo-5,5a,6,8,8a,9-hexahydrofuro[3',4':6,7]naphtho[2,3-*d*][1,3]dioxol-5-yl]amino}-1-butyl-1*H*-pyrrole-2,5-dione;
- 3-{[(5*S*,5a*S*,8a*R*,9*R*)-9-(4-hydroxy-3,5-dimethoxyphenyl)-8-oxo-5,5a,6,8,8a,9-hexahydrofuro[3',4':6,7]naphtho[2,3-*d*][1,3]dioxol-5-yl]amino}-1-allyl-1*H*-pyrrole-2,5-dione;
- 2-(3-{[(5*S*,5a*S*,8a*R*,9*R*)-9-(4-hydroxy-3,5-dimethoxyphenyl)-8-oxo-5,5a,6,8,8a,9-hexahydrofuro[3',4':6,7]naphtho[2,3-*d*][1,3]dioxol-5-yl]amino}-2,5-dioxo-2,5-dihydro-1*H*-pyrrol-1-yl) ethyl acetate;
- 3-{[(5*S*,5a*S*,8a*R*,9*R*)-9-(4-hydroxy-3,5-dimethoxyphenyl)-8-oxo-5,5a,6,8,8a,9-hexahydrofuro[3',4':6,7]naphtho[2,3-*d*][1,3]dioxol-5-yl]amino}-1-(2,3-dihydroxypropyl)-1*H*-pyrrole-2,5-dione;
- 3-{[(5*S*,5a*S*,8a*R*,9*R*)-9-(4-hydroxy-3,5-dimethoxyphenyl)-8-oxo-5,5a,6,8,8a,9-hexahydrofuro[3',4':6,7]naphtho[2,3-*d*][1,3]dioxol-5-yl]amino}-1-[2-(dimethylamino)ethyl]-1*H*-pyrrole-2,5-dione.

10. A method for the preparation of the compounds of the formula (I), wherein is used as starting product a compound of the formula (II):



(II)

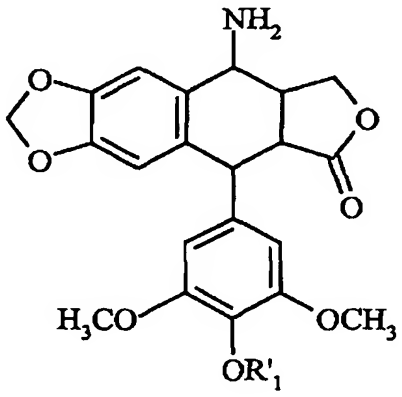
which is subjected, under basic conditions:

- either to the action of a compound of the formula (III):

R'_1-X (III)

wherein R'_1 represents a group chosen among straight or branched (C_1-C_6) alkyl, aryl, straight or branched (C_1-C_6) arylalkyl, heteroaryl, straight or branched (C_1-C_6) heteroarylalkyl, straight or branched (C_1-C_6) alkylcarbonyl, arylcarbonyl, straight or branched (C_1-C_6) arylalkylcarbonyl, straight or branched (C_1-C_6) alkoxycarbonyl, aryloxycarbonyl, straight or branched (C_1-C_6) arylalkoxycarbonyl, heterocycloalkoxycarbonyl, straight or branched (C_1-C_6) alkylsulfonyl, arylsulfonyl, straight or branched (C_1-C_6) arylalkylsulfonyl, phosphonic, or $Si(R_a)_2R_b$ wherein R_a and R_b, identical or different, each represent a group chosen among straight or branched (C_1-C_6) alkyl, or aryl,

and X represents a hydrogen atom, a halogen atom or an ordinary leaving group of organic chemistry, to lead to the compounds of the formula (IV/a):



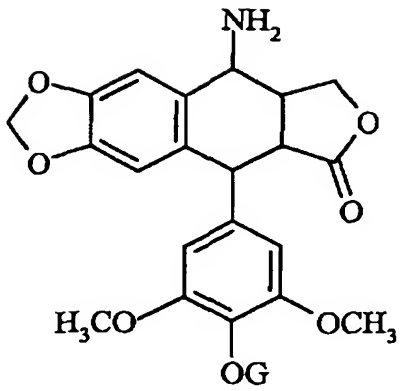
(IV/a)

wherein R'_1 is such as defined previously,

- or to the action of a compound of the formula (V):

G-L (V)

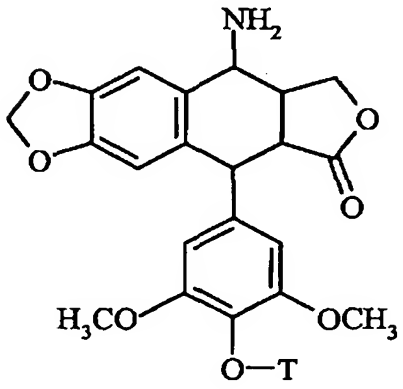
wherein G represents a traditional protective group of hydroxy functions and L an ordinary leaving group of organic chemistry, to lead to the compounds of the formula (IV/b):



(IV/b)

wherein G is such as defined previously,

the whole of the compounds of the formula (IV/a) and (IV/b) forming the compounds of the formula (IV):



(IV)

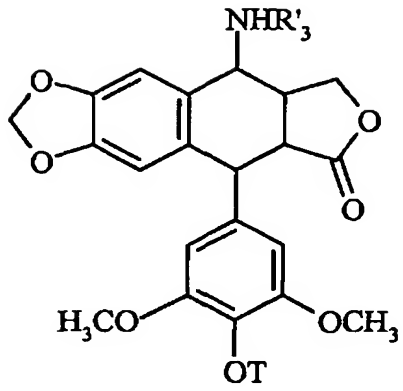
wherein T represents an R'_1 group or G such as previously defined,

a compound of the formula (IV), which is subjected, under basic conditions, to the action of a compound of the formula (VI):

$$R'_3\text{-}X' \quad (VI)$$

wherein R'_3 represents a group chosen among straight or branched (C_1-C_6) alkyl, cycloalkyl, straight or branched (C_1-C_6) cycloalkylalkyl, aryl or straight or branched (C_1-C_6) arylalkyl,

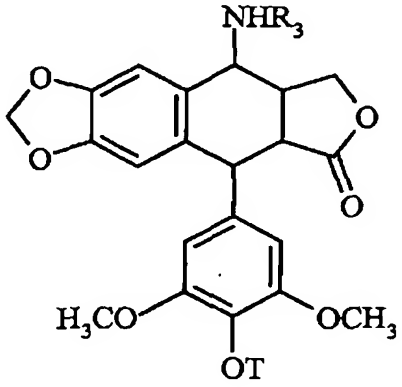
and X' represents a hydrogen atom, a halogen atom or an ordinary leaving group of organic chemistry, to lead to the compounds of the formula (VII):



(VII)

wherein R'_3 and T are such as previously defined,

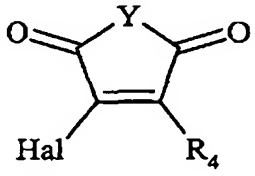
the whole of the compounds of the formulas (IV) and (VII) forming the compounds of the formula (VIII):



(VIII)

wherein R_3 and T are such as defined in the formula (I),

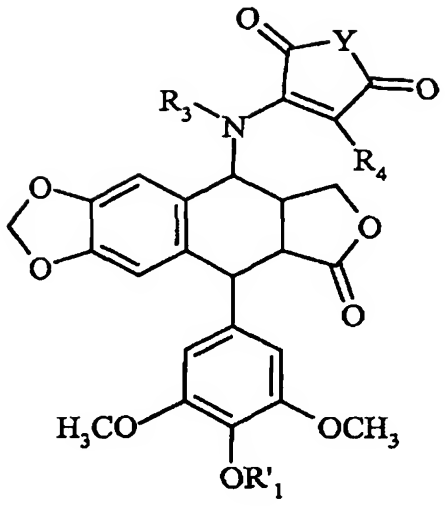
a compound of the formula (VIII) which are treated in a basic medium by a compound of the formula (IX):



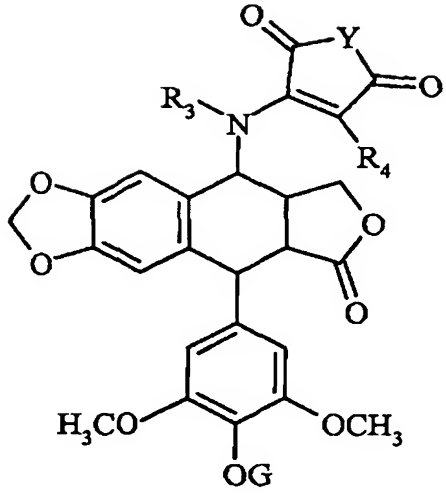
(IX)

wherein Y and R_4 are such as defined in the formula (I),

and Hal represents a halogen atom, to lead to the compounds of the formulas (I/a) and (I/b), specific cases of the compounds of the formula (I), according to whether T represents an R'_1 group or G, respectively:



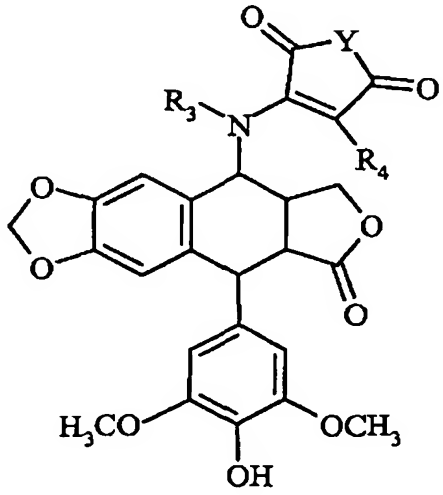
(I/a)



(I/b)

wherein R'_1, R_3, R_4, Y and G are such as previously defined,

a compound of the formula (I/b) wherein the hydroxy function is deprotected according to the traditional methods of organic chemistry, to lead to the compounds of the formula (I/c), specific cases of the compounds of the formula (I):



(I/c)

wherein R_3, R_4 and Y are such as previously defined,

the compounds (I/a) to (I/c) form the whole of the compounds of the invention, which can be purified, if necessary, according to a traditional purification technique,

which can, if it is desired, be separated into the various optical isomers thereof according to a traditional separation technique, and which can be transformed, if it is desired, into the addition salts thereof to a pharmaceutically acceptable acid or base.

11. Pharmaceutical compositions containing as an active ingredient at least one compound according to any of the claims 1 to 9, alone or in combination with one or more nontoxic, inert, pharmaceutically acceptable excipients or vehicles.

12. Pharmaceutical compositions according to the claim 11 useful as a drug, containing at least one active ingredient according to any of the claims 1 to 9, useful in the treatment of cancer.